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The Early Mobility Bundle

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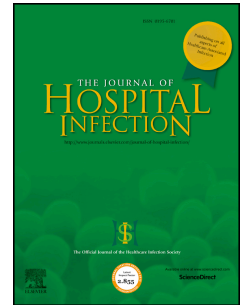
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Accepted Manuscript

The Early Mobility Bundle: a simple enhancement of therapy which may reduce incidence of hospital-acquired pneumonia and length of hospital stay

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M. Stolbrink et al.

The Early Mobility Bundle: a simple enhancement of therapy which may reduce incidence of hospital-acquired pneumonia and length of hospital stay

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SUMMARY

Background: Early mobility facilitated by physiotherapy has been shown to reduce the incidence of hospital-acquired pneumonia (HAP) in patients with hip fractures but its effect on HAP incidence in medical patients has not yet been studied.

Aim: To determine whether early mobility aided by physiotherapy reduces the incidence of HAP and length of stay in patients on medical wards.

Methods: One respiratory and one elderly care medicine ward in one hospital association in Birmingham, UK, received the 'Early Mobility Bundle'. The bundle consisted of extra targeted physiotherapy and collaboration with ward staff to encourage and promote activity. The incidence of HAP, falls, pressure sores, length of stay (LOS) and activity level were then compared to two matched wards within the same hospital association.

Results: HAP incidence was significantly lower in the intervention group ($P < 0.0001$) and remained so after adjusting for confounders ($P = 0.001$). Activity levels were higher ($P = 0.04$) and patients' LOS was more likely to fall in the shortest quartile (OR: 1.44; $P = 0.009$) in the intervention group. There was no significant difference in other outcomes.

Conclusion: The Early Mobility Bundle demonstrates a promising method to reduce the incidence of HAP and to increase activity in medical inpatients.

Keywords:

Activity

Hospital-acquired pneumonia

Length of stay

Physiotherapy

Introduction

Hospital-acquired infections (HAIs) are a growing concern in the western world due to their morbidity and cost, with pneumonia among the most frequently occurring. Hospital-acquired pneumonia (HAP) occurs ≥ 48 h after admission to hospital. In practice, the term HAP frequently includes ventilator-associated pneumonia (VAP; occurring ≥ 48 h after initiation of ventilator support) and the majority of the evidence base for prevention relates to this subgroup.¹ The incidence of HAP is estimated at five to 10 per 1000 hospital admissions, although there is no compulsory national reporting – hence this may be an underestimate. Mortality rates are 33–50% in the VAP subset, but there are no reliable published data on the prognosis of wider HAP groups.¹ However, mortality from community-acquired pneumonia (CAP) is higher among patients with pre-existing respiratory disease and those who are elderly, hence prevention of HAP in these subgroups could be particularly beneficial.^{2,3}

Inactivity and resultant reduced clearance of secretions are thought to be contributory factors to HAP development. Prevention strategies for VAP already include semi-recumbent (rather than supine) nursing and chest physiotherapy, both strategies aimed at clearing secretions more efficiently.^{1,4} Early physiotherapy, targeting mobility rather than chest secretions, is a recognized way of preventing HAIs and reducing hospital length of stay (LOS) in surgical specialties.^{5,6} In trauma patients with hip fractures this resulted in reduced incidence of HAP.⁷ The utility of directed physiotherapy in reducing incidence of HAP in medical patients has not been studied to date, although enhancing activity by early mobilization has reduced LOS in patients with CAP whereas individual physiotherapy had a similar effect on patients on elderly care, general medical and respiratory wards.^{8,9}

This study aimed to test the hypothesis that increased physiotherapy input results in a reduced incidence of HAP in patients admitted to respiratory and elderly care wards.

Methods

Study design

The study was conducted in a single hospital association in Birmingham, which has three hospital sites, and used a clustered design, such that patients on two wards (one elderly care, one respiratory) received the intervention and were compared to control patients on two similar specialty wards at a different hospital. The wards were chosen to attempt matching of patient population, and had minimal cross-over of staff. Patients admitted electively or whose primary reason for admission was surgical (e.g. hip fracture) were excluded from data analysis. The primary outcome was incidence of HAP (defined as new consolidation, persistent infiltrate or cavitation on chest radiograph >48 h after admission, confirmed by

independent radiological report, in conjunction with appropriate clinical features and/or treatment).¹⁰ Secondary outcomes were LOS, activity levels, rate of falls, and rate of pressure area problems. All data were collected prospectively and patients undergoing procedures beyond usual care gave informed consent. The study was approved by the local ethics committee (13/WM/0003) and registered as a clinical trial (NCT01769742).

The study ran for a duration of six months in 2013. Patients were recruited on the first day of admission to the study wards. Demographics, comorbidities, LOS, incidence of HAP, and activity level (measured by accelerometer) were collected daily. Activity recording was conducted only on patients able to mobilize (i.e. not bedbound) and able to give informed consent; monitoring was conducted for 48 h using the actigraph, worn at the waist at all times. Hospital reporting systems were used to back up data collected from medical notes and patients on falls and pressure sores.

Intervention

The 'Early Mobility Bundle' was developed by the therapy team to improve and maintain patient mobility through targeted physiotherapy and collaboration with ward staff. It was an enhancement of usual care and a change in ward culture rather than intensive individual therapy, as we wanted an intervention that would be sustainable after the study ended. The bundle consisted of enhancing the availability of walking aids, provision of occupational therapy equipment to maximize independence, addition of mobility charts, individual instructions and information above each patient's bed, and informing and encouraging all staff to support appropriate movement – for instance patients would be encouraged to get up from bed and walk to the food trolley. Charts were updated regularly by the study physiotherapist and compliance with the bundle monitored. Control wards received usual physiotherapy only. Medical care was not changed by the study team.

Statistical analysis

Statistical analysis was conducted using SPSS (version 19) comparing the intervention and control groups, with secondary substratification for ward specialty (elderly or respiratory). The χ^2 -test was used for initial analysis of HAP frequency, with subsequent logistic regression analysis used to adjust for significant confounding factors. Mean LOS was compared using the Mann–Whitney test due to non-normally distributed data, with subsequent regression. Normally distributed data are shown as mean (standard deviation; SD) and non-normally distributed data as median (range), with frequency variables shown as *n* (%). Statistical significance was assumed at $P < 0.05$. The analyst was blinded to the intervention or control groups.

Results

Table I shows the characteristics of patients on the intervention and control wards and simple unadjusted comparisons for each outcome measure. HAP incidence was lower ($P < 0.0001$) and patients were more active ($P = 0.04$) in the intervention group. There were some significant differences between the groups in terms of demographics, which directed subsequent multivariate analysis.

Hospital-acquired pneumonia

Since incidence of HAP might be influenced by the difference in admission condition, age, and patient comorbidity, these were adjusted for by logistic regression. Gender was also included in the initial model, as it differed between groups, although there was less biological plausibility to gender influencing HAP incidence than the other variables. The intervention remained associated with lower incidence of HAP with a hazard ratio (HR) of 0.39 [95% confidence interval (CI): 0.22–0.68; $P = 0.001$] (Figure 1A). Age was also associated with HAP risk, with an increase in age of one year being associated with an increase in HAP risk of 5% (95% CI: 2.5–7.5%; $P < 0.0001$). Male patients exhibited a trend towards increased incidence of HAP (HR 1.59; 95% CI: 0.95–2.59; $P = 0.08$). Those admitted with other infections tended to have lower incidence of subsequent HAP (HR 0.42; 95% CI: 0.17–1.05; $P = 0.06$). No other factors were significantly associated with HAP.

Length of stay

Due to the extremely skewed nature of the LOS data, with the vast majority of patients having relatively low LOS, but with a large range, it was not possible to construct a valid linear regression model. Since the intervention was most likely to affect patients with lower LOS, where comorbidity, severity of presenting problem and social factors might play a lesser role, logistic regression was performed to ascertain whether the intervention was independently associated with an LOS in the lowest quartile, adjusting for age, gender, admission problem, and comorbidity. Patients on intervention wards were more likely to be in the lowest LOS quartile (OR: 1.44; 95% CI: 1.09–1.89; $P = 0.009$) (Figure 1A). Older patients were less likely to be in this group (OR for increase in age of one year: 0.98; 95% CI: 0.97–0.99; $P < 0.001$), whereas admission problem showed a strong trend towards association overall ($P = 0.082$). Patients admitted with falls were least likely to be in the lowest LOS quartile (OR: 0.48; 95% CI: 0.28–0.84; $P = 0.01$). LOS was significantly longer in patients who had HAP (11.7 vs 33.4 days; $P < 0.01$).

Other outcomes

Falls appeared higher in the intervention group initially, but when specialty-specific analyses were conducted there was no significant difference in falls between those receiving and not receiving the intervention (Table II). Five out of six severe falls (associated with

injury, as opposed to non-severe falls, which have no consequence on patient health) occurred on control wards; all other falls were non-severe.

Since complete activity monitoring for 48 h was only conducted on a small proportion of patients ($n = 46$) it was not possible to conduct meaningful multivariate analysis on this outcome. However, since better mobility is likely to be the link between reduction in HAP and intervention, we believe that it is a valid result even in univariate form (Table I, Figure 1B). Moderate activity (equivalent to climbing the stairs) was only conducted for <5 min/day in the control group and <10 min/day in the intervention group. No patients conducted any bouts of activity of >10 min duration.

Subgroup analyses by specialty

The effect of the intervention was also analysed when stratified for medical specialty for our two main outcomes (HAP incidence and LOS), in order to ascertain whether the effect was greater in elderly or respiratory patients. Multivariate regressions were carried out as before. The reduction in HAP was most marked in elderly patients (HR: 0.17; 95% CI: 0.07–0.42; $P < 0.001$) compared to respiratory patients, in whom the effect was no longer significant (HR: 0.59; 95% CI: 0.29–1.21; $P = 0.15$). It is notable that a greater proportion of respiratory patients were admitted with problems requiring antibiotics to treat the chest [e.g. infective chronic obstructive pulmonary disease (COPD) exacerbation/bronchiectasis], which tended to associate with a lower risk of subsequent HAP. The effect of the intervention on LOS was smaller and lost significance in both subspecialties once subgroup analysis was undertaken; however, the trend was towards a greater effect in respiratory patients (OR for lowest quartile LOS: 1.32; 95% CI: 0.93–1.88; $P = 0.11$), with less effect in elderly care wards (OR: 1.25; 95% CI: 0.75–2.05; $P = 0.37$).

Discussion

This study has shown that simple physiotherapy measures are capable of reducing incidence of HAP and LOS in medical patients. These effects seem to be greatest in elderly patients, in whom loss of mobility and functional status during severe illness is likely to be most marked.

We chose incidence of HAP as our primary outcome measure because of its potential to be influenced by mobility, unlike other HAIs, such as *Clostridium difficile*, where infection control practices such as handwashing are more important.¹¹ Consistent with other published data in CAP, it appeared that HAP was associated with increasing age, perhaps because of decreasing immune system function with advancing years.^{12,13} Prior published work has shown that comorbidity burden, unlike age, is a key driver of mortality in HAP, and that it also influences microbiological cause; unfortunately our dataset had too few HAP cases to

reliably assess this in each arm of our trial.¹⁴ HAP was also less common in those receiving antibiotic therapy for their presenting problem, perhaps partly due to shorter LOS associated with some such illnesses.

We recognized that LOS would potentially be influenced by many factors (including a reduction in HAP incidence itself), and therefore be a harder measure for which to prove significant effects, but it was chosen as an outcome measure as it influences financial impact of the intervention and therefore the business case for wider implementation. The univariate analysis apparently showing prolonged LOS in the intervention group is not clinically meaningful due to the differences between groups and skewed nature of the LOS data. Once adjustment for these confounding factors had been undertaken in the multivariate analysis, the intervention was associated with increased likelihood of being in the lowest LOS quartile. Future studies might focus on defined LOS periods to avoid confusion. Increasing age and admission due to falls were associated with longer LOS, consistent with prior work assessing age and the impact of admission after falls, even when these do not result in fracture.^{15–17}

A measure of physical activity was included as a secondary outcome, as it was felt that this was likely to be the mechanism underlying any observed improvement in HAP or LOS. Physical activity questionnaires correlate with gold standard measures only at high-intensity activity, thus limiting their use in chronically disabled populations, which include many hospital inpatients.¹⁸ Indeed our own data in respiratory patients concurred with this previously, such that very few patients' questionnaires tied in well to actual activity monitoring.¹⁹ We therefore measured activity using an accelerometer; these measure intensity and frequency of movement in several planes and may estimate energy expenditure.¹⁸ Our monitor (actigraph) was used in the NHANES survey and has been validated independently in COPD patients.^{20–22} It has a function which allows detection of activity in slow-moving or relatively inactive patients (low frequency extension), thus we felt it likely to be suitable for hospital inpatients. An acceptable intraclass reliability coefficient (>0.70) was demonstrated previously when activity monitors were worn for two days by COPD patients, suggesting that 48 h monitoring would be adequate in our patient group.²³ Although activity levels were higher in the intervention wards, it is important to note that very little of the activity was of intensity likely to benefit cardiovascular health, upon which Department of Health recommendations are based, comprising 30 min of moderate intensity physical activity on five or more days of the week in people who are well or 10,000 steps a day.^{24,25} Clearly hospital inpatients would not be expected to achieve this, but the amounts of time during which patients were active strikingly low. The fact that a culture change for the ward staff

combined with a relatively low-intensity intervention such as the Early Mobility Bundle was associated with a doubling in activity levels emphasizes that this is amenable to change.

The higher rate of falls in the intervention wards appears concerning. However, this is likely to be due to a combination of reporting bias from the elderly care intervention ward, which has a strong ward culture regarding falls reporting and management, and higher turnover in the intervention wards. Further study of this element would be critical in later studies.

Our trial has some key strengths – primarily its real-life design, suggesting feasible implementation and results generalizable to UK hospitals. It also cost relatively little, thus would be financially viable; there were 25 fewer HAP cases, and HAP patients had longer LOS (average 22 days longer). Whereas it is not possible completely to tease out cause and effect, any intervention that saves 550 bed-days represents a large potential saving. This would more than pay for the Band 3 physiotherapy assistants employed to deliver the intervention. The large number of patients enrolled also adds weight to our findings.

Limitations of our data come mainly from the study design, which was chosen pragmatically to maximize output from a very small research grant and minimize confounding by cross-over of staff between wards. Adequate matching did not occur by chance, despite the large size of this clustered trial. There are potentially two reasons for this. First, wards can easily become and remain biased towards one gender due to high bed occupancy rates and single sex bays, as it is impossible to move male patients into a female bed space, and any one ward will not have more than a handful of beds becoming free each day. Second, the sociodemographics and primary care services differ between our two sites – the (control) site in an affluent area tends to admit older patients, and has more complete medical and social service integration. Further work would need to take into account such factors in the study design.

In conclusion, mobilizing patients early and engendering an attitude that promotes independence for most patients is capable of reducing the incidence of HAP, and improving LOS in medical patients, without any significant evidence of harm. Larger randomized studies are now indicated to definitively prove clinical and cost-effectiveness.

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Conflict of interest statement

None declared.

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Table I

Characteristics of the study population and univariate statistics for outcome measures

	Intervention (<i>N</i> = 678)	Control (<i>N</i> = 501)	<i>P</i> -value
Age (years), median (range)	75 (17–100)	81 (16–102)	<0.0001
Male gender, <i>n</i> (%)	333 (49.1)	145 (26.3)	<0.0001
Presenting problem, <i>n</i> (%)			<0.0001 ^a
Community-acquired pneumonia	110 (15.6)	71 (12.9)	
Other infections	56 (8.0)	88 (16.0)	
Exacerbation of COPD	131 (18.6)	62 (11.3)	
Other respiratory conditions	145 (20.6)	84 (15.2)	
Fall	72 (10.2)	92 (16.7)	
Congestive cardiac failure	23 (3.3)	27 (4.9)	
Cancer	36 (5.1)	24 (4.4)	
Vascular disease including TIA and IHD	14 (2.0)	22 (4.0)	
Other medical problems	116 (16.5)	81 (14.7)	
No. of comorbidities, median (range)	3 (0–11)	1 (0–9)	<0.0001
HAP incidence, <i>n</i> (%)	25 (3.6)	50 (10.0)	<0.0001
Length of stay (days), median (range)	9 (1–114)	8 (1–145)	0.356
Falls, <i>n</i> (%)	198 (29.2)	92 (18.4)	0.001
Pressure sores, <i>n</i> (%)	60 (8.8)	46 (9.2)	0.857
Minutes active/day (total <i>n</i> = 46)	83.1 (44.9)	40.5 (26.8)	0.044
Step count/day (total <i>n</i> = 46)	1103 (103.8)	388 (90.5)	0.032

COPD, chronic obstructive pulmonary disease; TIA, transient ischaemic attack; IHD, ischaemic heart disease; HAP, hospital-acquired pneumonia.

^a χ^2 of overall distribution of presenting problems.

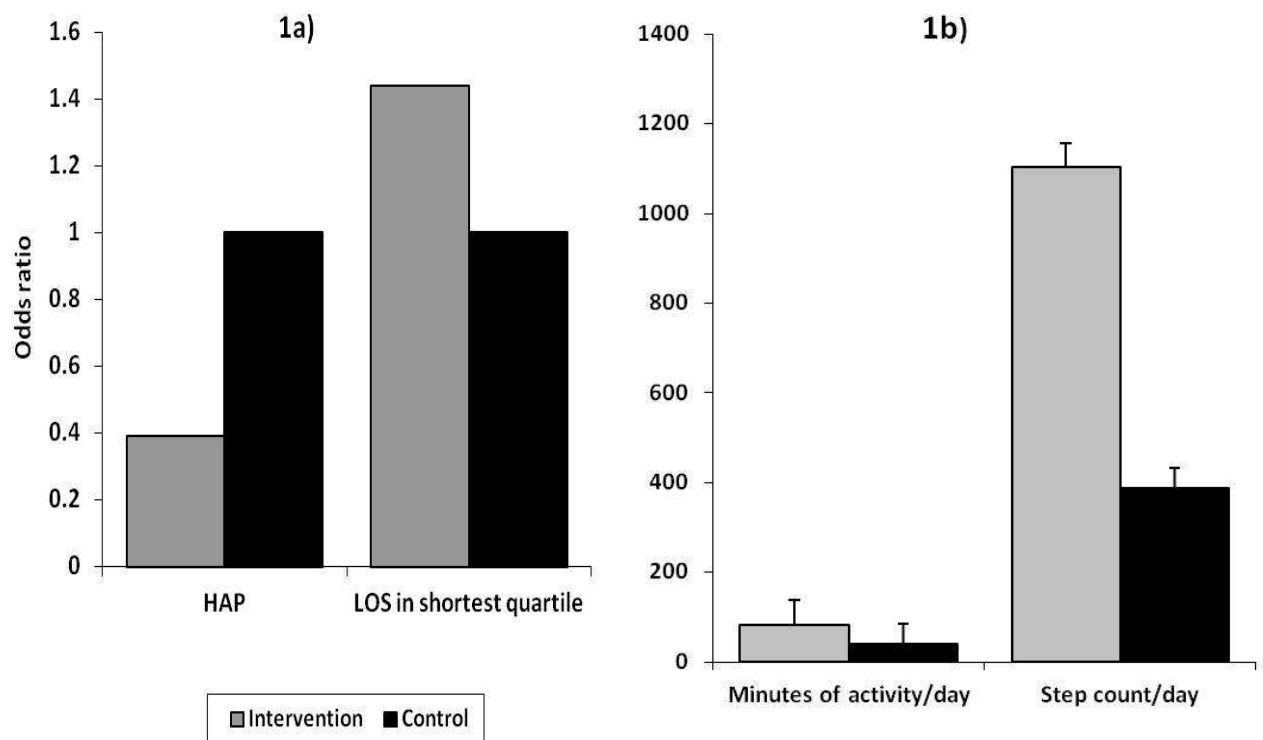


Figure 1. Outcomes of the Early Mobility Bundle. (A) Odds ratios from the multivariate models for the two main outcomes: incidence of hospital-acquired pneumonia and short hospital stay. The intervention improved both measures ($P = 0.001$ and $P = 0.009$ respectively). (B) Improvement in both activity level and step count seen in the intervention group ($n = 46$, $P = 0.04$ and $P = 0.03$ respectively). Grey bars, intervention; black bars, control. LOS, length of stay.

Table II

Total number of falls in intervention and control wards shown by specialty

Specialty	Control	Intervention	Total	<i>P</i> -value ^a
Respiratory	37	80	117	0.184
Elderly care	55	118	173	0.292
Total	92	198		

^aRate of falls (total number of falls in specialty and intervention group/total number of patients admitted to this specialty and intervention group). Since some patients experienced several falls, whereas others experienced none, the values as percentage of the total patient numbers per ward are not shown.